**Claims**

1. A variable gain amplifier comprising:

a main input terminal for receiving an input signal to be amplified,

a main output terminal for outputting the amplified signal,

N selectively selectable gain stages, where N is an integer greater than one, for amplifying the input signal, the gain stages having respective signal outputs for providing the amplified input signal to the main output terminal, a first of the N gain stages being coupled to the main input terminal,

a voltage divider impedance chain, a first end of which is coupled to the main input terminal, the voltage divider impedance chain having (N-1) output taps coupled to respective ones of the gain stages from a second one to an Nth one of the N gain stages for applying the input signal to the gain stages from the second to Nth gain stage progressively attenuated from the second gain stage to the Nth gain stage,

a selectively operable shunt-shunt feedback circuit for feeding back the amplified input signal from at least one of the gain stages to the main input terminal for varying the input impedance of the variable gain amplifier,

at least one passive shunt impedance element selectively switchable to the main input terminal for varying the input impedance of the variable gain amplifier, and

a control circuit for selecting the feedback circuit and the at least one passive shunt impedance element in response to the selected gain stage for maintaining the input impedance of the variable gain amplifier within a predetermined input impedance range.

2. A variable gain amplifier as claimed in Claim 1 in which the feedback circuit is arranged for feeding back the amplified input signal from the first one of the N gain stages to the main input terminal.

3. A variable gain amplifier as claimed in Claim 1 in which the feedback circuit feeds back the amplified input signal to the main input terminal independently of the signal on the main output terminal.

4. A variable gain amplifier as claimed in Claim 1 in which the signal outputs of the gain stages are coupled to the main output terminal, and the feedback circuit is operably coupled

between the main output terminal and the main input terminal.

5. A variable gain amplifier as claimed in Claim 1 in which the feedback circuit and the at least one passive shunt impedance element are alternately selectable by the control circuit.

6. A variable gain amplifier as claimed in Claim 1 in which the feedback circuit and the at least one passive shunt impedance element are simultaneously selectable by the control circuit.

7. A variable gain amplifier as claimed in Claim 1 in which the at least one passive shunt impedance element is selected by the control circuit when the shunt impedance value applied to the main input terminal by the feedback circuit is insufficient for maintaining the input impedance of the variable gain amplifier within the predetermined input impedance range.

8. A variable gain amplifier as claimed in Claim 1 in which a plurality of passive shunt impedance elements are provided, the passive shunt impedance elements being selectively selectable by the control circuit in response to the selected gain stage.

9. A variable gain amplifier as claimed in Claim 1 in which the impedance values of the respective passive shunt impedance elements are the same or different.

10. A variable gain amplifier as claimed in Claim 1 in which each passive shunt impedance element comprises a passive resistive element.

11. A variable gain amplifier as claimed in Claim 1 in which the shunt impedance value applied to the main input terminal by the feedback circuit is selectively variable under the control of the control circuit in response to the selected gain stage.

12. A variable gain amplifier as claimed in Claim 1 in which the feedback circuit comprises an input terminal coupled to the main output terminal, an output terminal coupled to the main input terminal, and a transconductance device for feeding a bias current to the main input terminal through the output terminal.

13. A variable gain amplifier as claimed in Claim 12 in which the bias current of the transconductance device of the feedback circuit is variable under the control of the control circuit in response to the selected gain stage.

14. A variable gain amplifier as claimed in Claim 13 in which the feedback circuit comprises a control terminal for receiving a control signal from the control circuit for setting the bias current of the transconductance device.

15. A variable gain amplifier as claimed in Claim 14 in which the value of the control signal for controlling the bias current of the transconductance device is selectable by the control circuit in response to the selected gain stage.

16. A variable gain amplifier as claimed in Claim 12 in which the output of the feedback circuit is fed back to the inverting input of an operational amplifier, a control voltage being applied to the non-inverting input of the operational amplifier, and an output of the operational amplifier is coupled to the transconductance device for controlling the bias voltage of the transconductance device so that the output voltage on the output terminal of the feedback circuit is driven to the value of the control voltage applied to the non-inverting input of the operational amplifier.

17. A variable gain amplifier as claimed in Claim 12 in which the input terminal to the feedback circuit is AC coupled to the main output terminal.

18. A variable gain amplifier as claimed in Claim 1 in which each gain stage comprises an amplifier element comprising a transconductance device to which the input signal is amplified.

19. A variable gain amplifier as claimed in Claim 18 in which the gain of the amplifier element of at least some of the gain stages is variable under the control of the control circuit.

20. A variable gain amplifier as claimed in Claim 19 in which the feedback circuit and the at least one passive shunt impedance element are selected by the control circuit in response to the selected gain of the amplifier element of the selected gain stage.

21. A variable gain amplifier as claimed in Claim 20 in which the value of the control signal for controlling the bias current of the transconductance device of the feedback circuit is selected in response to the selected gain of the amplifier element of the selected gain stage.

22. A variable gain amplifier as claimed in Claim 18 in which the voltage divider impedance chain is a capacitive voltage divider comprising a plurality of capacitive elements defining the output taps therebetween.

23. A variable gain amplifier as claimed in Claim 22 in which the capacitance of the capacitive elements between the output taps of the voltage divider impedance chain are selected to take account of the parasitic capacitance of the transconductance devices of the respective amplifier elements of the gain stages for determining the attenuation of the input signal at the respective output taps.

24. A variable gain amplifier as claimed in Claim 23 in which the capacitance of the capacitive elements of the voltage divider impedance chain are selected to take account of the parasitic capacitance of the transconductance devices of the respective amplifier elements of the gain stages when the transconductance devices thereof are biased with a voltage of value such that the voltage dependency of the parasitic capacitance of the transconductance devices is minimised.

25. A variable gain amplifier as claimed in Claim 22 in which the capacitance of the capacitive elements of the voltage divider impedance chain are selected for linearising the attenuation on a logarithmic scale of the input signal presented sequentially on the output taps from the first output tap to the (N-1) output tap.

26. A variable gain amplifier as claimed in Claim 1 in which the impedance value between each pair of adjacent output taps of the voltage divider impedance chain is selected so that the attenuating effect of the voltage divider impedance chain between each pair of adjacent output taps does not exceed the range over which the gain of the preceding gain stage may be varied.

27. A variable gain amplifier as claimed in Claim 26 in which the impedance value between each pair of adjacent output taps of the voltage divider impedance chain is selected so that the attenuating effect of the voltage divider impedance chain between each pair of adjacent output taps is substantially similar to the range over which the gain of the preceding gain stage may be varied.

28. A variable gain amplifier as claimed in Claim 1 in which a second end of the voltage divider impedance chain is coupled to a reference ground.

29. A variable gain amplifier as claimed in Claim 18 in which each amplifier element comprises a first bias voltage terminal for receiving a first bias voltage for applying to the transconductance device thereof for minimising the voltage dependency of the parasitic capacitance of the transconductance device when the gain stage comprising that amplifier element is not selected.

30. A variable gain amplifier as claimed in Claim 29 in which the first bias voltage terminal is selectively switchable to the transconductance device under the control of the control circuit.

31. A variable gain amplifier as claimed in Claim 29 in which the first bias voltage terminal of each amplifier element is coupled to the transconductance device thereof through a first impedance circuit.

32. A variable gain amplifier as claimed in Claim 31 in which the impedance of the first impedance circuit of each amplifier element is greater than the source impedance presented to the amplifier element so that the influence of the first bias voltage on the frequency characteristic of the voltage divider impedance chain remains substantially negligible when the gain stage comprising that amplifier element is not selected.

33. A variable gain amplifier as claimed in Claim 18 in which each amplifier element comprises a second bias voltage terminal for receiving and applying a second bias voltage to the transconductance device thereof for biasing the transconductance device of the amplifier element when the gain stage comprising the amplifier element is selected.

34. A variable gain amplifier as claimed in Claim 33 in which the second bias voltage terminal of each amplifier element is selectively switchable to the transconductance device thereof under the control of the control circuit.

35. A variable gain amplifier as claimed in Claim 33 in which the second bias voltage terminal of each amplifier element is coupled to the transconductance device thereof through a second impedance circuit, the impedance of the second impedance circuit being greater than the source impedance presented to the amplifier element so that the influence of the second bias voltage on the frequency characteristic of each amplifier element remains substantially negligible when the gain stage comprising that amplifier element is selected.

36. A variable gain amplifier as claimed in Claim 1 in which the gain stages are the same or different.

37. A variable gain amplifier as claimed in Claim 1 in which only one gain stage is selectable at one time.

38. A variable gain amplifier as claimed in Claim 1 in which the N gain stages are arranged in M groups, where M is an integer from 2 upwards, and M main output terminals are provided, the outputs of the gain stages of the respective groups being coupled to corresponding ones of the M main output terminals, with the outputs of the gain stages of a first group of the M groups of gain stages being coupled to a first one of the M main output terminals, and the outputs of the gain stages of an Mth group of the M groups of gain stages being coupled to an Mth one of the M main output terminals.

39. A variable gain amplifier as claimed in Claim 38 in which the feedback circuit is operably coupled between the main input terminal and one of the M main output terminals.

40. A variable gain amplifier as claimed in Claim 38 in which the first group of the M groups of gain stages provides the greatest gain.

41. A variable gain amplifier as claimed in Claim 38 in which the feedback circuit is coupled to the first main output terminal of the M main output terminals.

42. A variable gain amplifier as claimed in Claim 38 in which a plurality of feedback circuits are provided corresponding to respective ones of at least some of the M main output terminals for feeding back the output signals on the corresponding ones of the at least some of the M main output terminals to the main input terminal.

43. A variable gain amplifier as claimed in Claim 1 in which a shunt peak output load element is coupled to each main output terminal for enhancing the bandwidth of the variable gain amplifier and minimising power consumption.

44. A variable gain amplifier as claimed in Claim 18 in which the variable gain amplifier is a differential variable gain amplifier comprising a pair of main input terminals for receiving respective positive and negative ends of a differential input signal, a pair of main output terminals for outputting respective positive and negative ends of the amplified differential output signal, each gain stage comprising a pair of amplifier elements for amplifying the corresponding ones of the positive and negative ends of the differential input signal, and for outputting the amplified positive and negative signals on the respective corresponding main output terminals, and a pair of voltage divider impedance chains coupled to the respective main input terminals for applying the positive and negative ends of the differential input signal to the corresponding amplifier elements of the second to the Nth gain stage.

45. A variable gain amplifier comprising:

a main input terminal for receiving an input signal to be amplified,

a main output terminal for outputting the amplified signal,

N selectively selectable gain stages, where N is an integer greater than one, each gain stage comprising:

an amplifier element comprising a transconductance device for amplifying the input signal, a signal output for providing the amplified signal to the main output terminal, and a signal input, the signal input of the amplifier element of a first of the N gain stages being coupled to the main input terminal,

a first bias voltage terminal being provided to each amplifier element for receiving a first bias voltage for applying to the transconductance device, the first bias voltage being of value for minimising the voltage dependency of the parasitic capacitance of the transconductance device when the corresponding gain stage is not selected,

a voltage divider impedance chain, a first end of which is coupled to the main input terminal, the voltage divider impedance chain having (N-1) output taps coupled to the signal inputs of the amplifier elements of the respective ones of the gain stages from a second one to an Nth one of the N gain stages for applying the input signal to the amplifier elements of the gain stages from the second to the Nth gain stage progressively attenuated from the second gain stage to the Nth gain stage.

46. A variable gain amplifier comprising:

a main input terminal for receiving an input signal to be amplified,

a main output terminal for outputting the amplified signal,

an amplifier element of selectable gain having a signal input for receiving an input signal from the main input terminal, and a signal output for providing the amplified input signal to the main output terminal,

a selectively operable shunt-shunt feedback circuit for feeding back the amplified input signal from the amplifier element to the main input terminal for varying the input impedance of the variable gain amplifier,

at least one passive shunt impedance element selectively switchable to the main input terminal for varying the input impedance of the variable gain amplifier, and

a control circuit for selecting the feedback circuit and the at least one passive shunt impedance element in response to the selected gain of the amplifier element for maintaining the input impedance of the variable gain amplifier within a predetermined input impedance range.